THE AGB NEWSLETTER

An electronic publication dedicated to Asymptotic Giant Branch stars and related phenomena

Official publication of the IAU Working Group on Abundances in Red Giants

No. 238 — 1 May 2017

http://www.astro.keele.ac.uk/AGBnews

Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

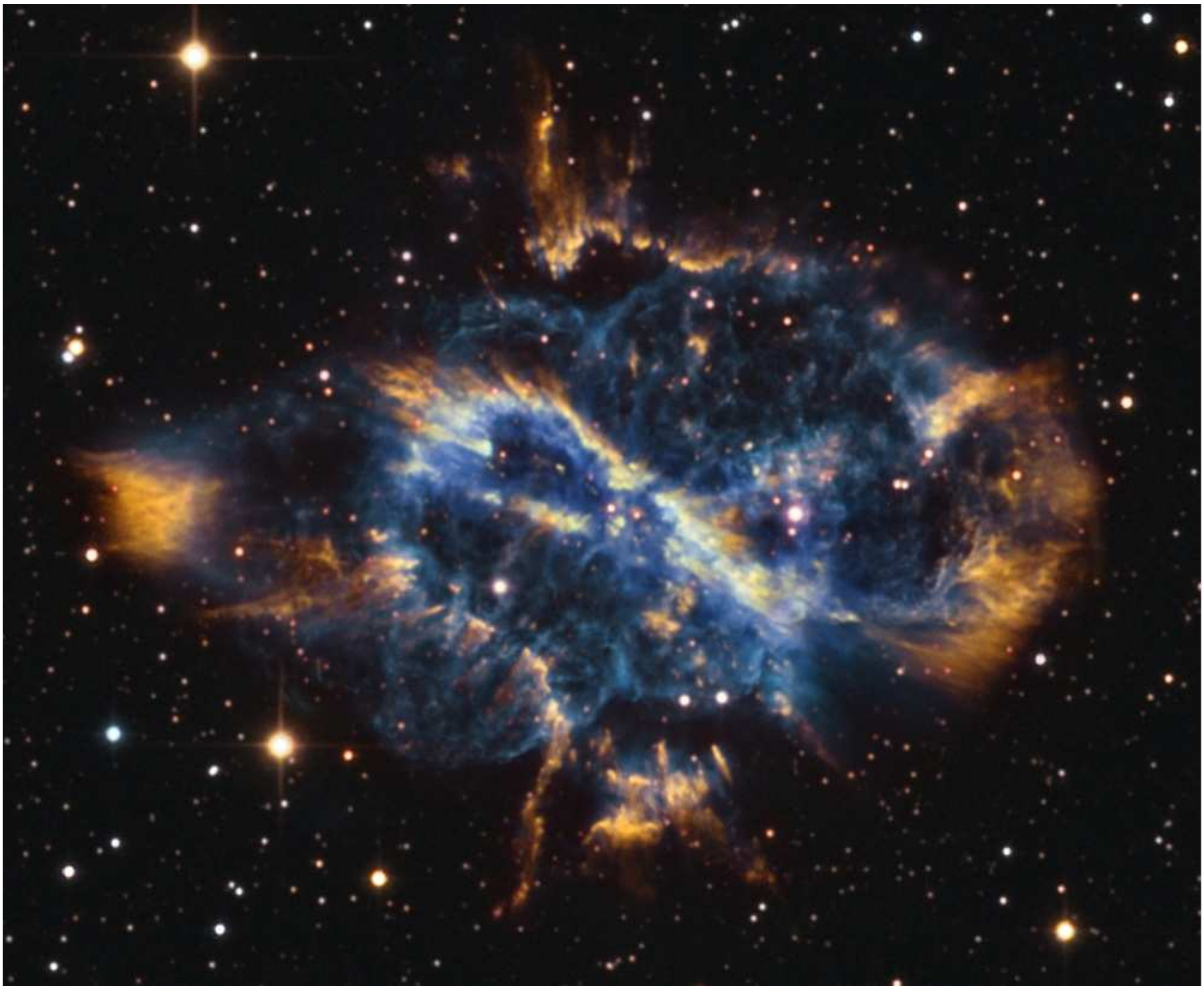

Figure 1: The planetary nebula NGC 5189 in Musca was imaged by the CHART32 team in Chile, using a combination of [S II], Hα and [O III] filters (rendered in an RGB colour composite). The Southern African Large Telescope found the central star is an exotic binary (Manick, Miszalski & McBride 2015) – for more results obtained with SALT see the first item in this newsletter!

Editorial

Dear Colleagues,

It is a pleasure to present you the 238th issue of the AGB Newsletter. PN binary central stars, white dwarfs, grain formation, pulsation, extragalactic populations... you name it.

Don't miss the review paper on Super-AGB stars written by today's experts in the field.

Great times for those looking for jobs: postdoctoral positions in Canada and Madrid, and a PhD position in South Africa.

Why not take a Cloudy training course in Belfast, before attending the 7th Asymmetric Planetary Nebulæ conference in Hong Kong?

Thanks again to Sakib Rasool for suggesting the beautiful and intriguing picture for the front cover. If you would like to suggest an image, graph or spectrum for the front cover just let us know.

The next issue is planned to be distributed around the 1st of June.

Editorially Yours,
Jacco van Loon, Ambra Nanni and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

What is the roundest planetary nebula – and why?

Reactions to this statement or suggestions for next month's statement can be e-mailed to astro.agbnews@keele.ac.uk (please state whether you wish to remain anonymous)

Refereed Journal Papers

SALT HRS discovery of a long period double-degenerate binary in the planetary nebula NGC 1360

B. Miszalski[1,2], *R. Manick*[3], *J. Mikołajewska*[4], *K. Iłkiewicz*[4], *D. Kamath*[5,6,7,3] *and H. Van Winckel*[3]

[1]South African Astronomical Observatory, P.O. Box 9, Observatory, 7935, South Africa
[2]Southern African Large Telescope Foundation, P.O. Box 9, Observatory, 7935, South Africa
[3]Instituut voor Sterrenkunde, K.U. Leuven, Celestignenlaan 200D bus 2401, B-3001 Leuven, Belgium
[4]Nicolaus Copernicus Astronomical Center, Polish Academy of Sciences, Bartycka 18, PL-00716 Warsaw, Poland
[5]Department of Physics and Astronomy, Macquarie University, Sydney NSW 2109, Australia
[6]Astronomy, Astrophysics and Astrophotonics Research Centre, Macquarie University, Sydney NSW 2109, Australia
[7]Australian Astronomical Observatory, P.O. Box 915, North Ryde, NSW 1670, Australia

Whether planetary nebulæ (PNe) are predominantly the product of binary stellar evolution as some population synthesis models (PSM) suggest remains an open question. Around 50 short period binary central stars ($P \sim 1$ d) are known, but with only four known with $P > 10$ d our knowledge is severely incomplete. Here we report on the first discovery from a systematic SALT HRS survey for long period binary central stars. We find a 142 d orbital period from radial velocities of the central star of NGC 1360, HIP 16566, infamous for its now disproven kilogauss magnetic field. NGC 1360 appears to be the product of common-envelope (CE) evolution with an orbital period at the upper range predicted for post-CE PSM and nebula features similar to post-CE PNe. The most striking feature is a newly-identified ring of low-ionisation structures (LIS) whose inclination matches $i = 30 \pm 10$ deg from spatio-kinematic modelling of the nebula. Assuming a binary coplanar with the nebula, multi-wavelength observations best fit an evolved WD companion with $M = 0.7$ M$_\odot$, $L \sim 50$ L$_\odot$ and $T_{\rm eff} = 115$ kK. Nebular kinematics also indicate fallback of CE ejecta occurred in NGC 1360 and simulations show that ~ 0.2 M$_\odot$ could have formed into a circumbinary disk. Photoionisation and fragmentation of such a disk, or a post-AGB binary disk that survived into the PN phase, may be central to forming the ring of LIS. Large radial velocity variability detected by lower resolution surveys suggests long period binaries may be much more common than PSM models predict, supporting a 40–50% total binary fraction for PNe.

Submitted to MNRAS
Available from https://arxiv.org/abs/1703.10891

The binarity of the local white dwarf population

S. Toonen[1], *M. Hollands*[2], *B. Gänsicke*[2] *and T. Boekholt*[1]

[1]Leiden Observatory, Leiden University, P.O. Box 9513, NL-2300 RA Leiden, The Netherlands
[2]Department of Physics, University of Warwick, Coventry CV4 7AL, UK

White dwarfs (WDs) are powerful tools to study the evolutionary history of stars and binaries in the Galaxy. But do we understand their multiplicity from a theoretical point of view? This can be tested by a comparison with the sample of WDs within 20 pc, which is minimally affected by selection biases. From the literature, we compile the available information of the local WD sample with a particular emphasis on their multiplicity, and compare this to synthetic models of WD formation in single stars and binaries. As part of our population synthesis approach, we also study the effect of different assumptions concerning the star formation history, binary evolution, and the initial distributions of binary parameters. We find that the observed space densities of single and binary WDs are well reproduced by the models. The space densities of the most common WD systems (single WDs and unresolved WD–MS binaries) are consistent within a factor two with the observed value. We find a discrepancy only for the space density of resolved

double WDs. We exclude that observational selection effects, fast stellar winds, or dynamical interactions with other objects in the Milky Way explain this discrepancy. We find that either the initial mass ratio distribution in the Solar neighbourhood is biased towards low mass-ratios, or more than ten resolved DWDs have been missed observationally in the 20 pc sample. Furthermore, we show that the low binary fraction of WD systems ($\sim 25\%$) compared to Solar-type MS–MS binaries ($\sim 50\%$) is consistent with theory, and is mainly caused by mergers in binary systems, and to a lesser degree by WDs hiding in the glare of their companion stars. Lastly, Gaia will dramatically increase the size of the volume-limited WD sample, detecting the coolest and oldest WDs out to 50 pc. We provide a detailed estimate of the number of single and binary WDs in the Gaia sample.

Accepted for publication in A&A
Available from https://arxiv.org/abs/1703.06893
and from https://staff.fnwi.uva.nl/s.g.m.toonen/

The halo of M 49 and its environment as traced by planetary nebulæ

J. Hartke[1], *M. Arnaboldi*[1,2], *A. Longobardi*[3,4], *O. Gerhard*[4], *K.C. Freeman*[5], *S. Okamura*[6] *and F. Nakata*[7]

[1]European Southern Observatory, Karl-Schwarzschild-Str. 2, 85748 Garching bei München, Germany
[2]INAF, Observatory of Pino Torinese, Turin, Italy
[3]Kavli Institute for Astronomy and Astrophysics, Peking University, 5 Yiheyuan Road, Haidian District, Beijing 100871, P.R. China
[4]Max-Planck-Institut für Extraterrestrische Physik, Gießenbachstraße, 85748 Garching bei München, Germany
[5]RSAA, Mt. Stromlo Observatory, 2611 Canberra, Australia
[6]Department of Advanced Sciences, Faculty of Science and Engineering, Hosei University, 184-8584 Tokyo, Japan
[7]Subaru Telescope, National Astronomical Observatory of Japan, 650 N. Aohoku Place, Hilo HI96720, U.S.A.

The galaxy M 49 (NGC 4472) is the brightest early-type galaxy in the Virgo Cluster. It is located in Subcluster B and has an unusually blue, metal-poor outer halo. Planetary nebulæ (PNe) are excellent tracers of diffuse galaxy and intragroup light. We present a photometric survey of PNe in the galaxy's extended halo to characterise its PN population, as well as the surrounding intragroup light (IGL) of the Subcluster B. PNe were identified based on their bright [O III]5007 Å emission and absence of a broad-band continuum. We identify 738 PNe out to a radius of 155 kpc from M 49's centre from which we define a complete sample of 624 PNe within a limiting magnitude of $m_{5007} = 28.8$. Comparing the PN number density to the broad-band stellar surface brightness profile, we find a variation of the PN-specific frequency (α-parameter) with radius. The outer halo beyond 60 kpc has a 3.2 times higher α-parameter compared to the main galaxy halo, which is likely due to contribution from the surrounding blue IGL. We use the Planetary Nebulæ Luminosity Function (PNLF) as an indicator of distance and stellar population. Its slope, which correlates empirically with galaxy type, varies within the inner halo. In the eastern quadrant of M 49, the PNLF slope is shallower, indicating an additional localised, bright PN population following an accretion event, likely that of the dwarf irregular galaxy VCC 1249. We also determined a distance modulus of $\mu = 31.29 \pm 0.08$ for M 49, corresponding to a physical distance of 18.1 ± 0.6 Mpc, which agrees with a recent surface-brightness fluctuations distance. The PN populations in the outer halo of M 49 are consistent with the presence of a main Sérsic galaxy halo with a slight (B–V) colour gradient of 10^{-4} mag arcsec^{-1} surrounded by intragroup light with a very blue colour of $(B - V) = 0.25$ mag and a constant surface brightness $\mu_V = 28.0$ mag arcsec^{-2}.

Accepted for publication in A&A
Available from https://arxiv.org/abs/1703.06146
and from https://doi.org/10.1051/0004-6361/201730463

A pilot search for mm-wavelength recombination lines from emerging ionized winds in pre-planetary nebulæ candidates

C. Sánchez Contreras[1], *A. Báez-Rubio*[2], *J. Alcolea*[3], *V. Bujarrabal*[3] *and J. Martín-Pintado*[1]

[1]Centro de Astrobiología (CSIC–INTA), Spain

[2]Instituto de Astronomía, Universidad Nacional Autónoma de México, México

[3]Observatorio Astronómico Nacional (IGN), Spain

We report the results from a pilot search for radio recombination line (RRL) emission at millimeter wavelengths in a small sample of pre-planetary nebulæ (pPNe) and young PNe (yPNe) with emerging central ionized regions. Observations of the H30α, H31α, H39α, H41α, H48β, H49β, H51β, and H55γ lines at 1 and 3 mm have been performed with the IRAM 30 m radio telescope. These lines are excellent probes of the dense inner ($\lesssim$150 au) and heavily obscured regions of these objects, where the yet unknown agents for PN-shaping originate. We detected mm-RRLs in three objects: CRL 618, MWC 922, and M 2-9. For CRL 618, the only pPN with previous published detections of H41α, H35α, and H30α emission, we find significant changes in the line profiles indicating that current observations are probing regions of the ionized wind with larger expansion velocities and mass-loss rate than $\sim$ 29 years ago. In the case of MWC 922, we observe a drastic transition from single-peaked profiles at 3 mm to double-peaked profiles at 1 mm, which is consistent with maser amplification of the highest frequency lines; the observed line profiles are compatible with rotation and expansion of the ionized gas, probably arranged in a disk+wind system around a $\sim$ 5–10 $M_\odot$ central mass. In M 2-9, the mm-RRL emission appears to be tracing a recent mass outburst by one of the stars of the central binary system. We present the results from non-LTE line and continuum radiative transfer models, which enables us to constrain the structure, kinematics, and physical conditions (electron temperature and density) of the ionized cores of our sample. (abridged). We deduce mass-loss rates of $\sim 1 \times 10^{-6}$–1×10^{-7} $M_\odot$ yr^{-1}, which are significantly higher than the values adopted by stellar evolution models currently in use and would result in a transition from the asymptotic giant branch to the PN phase faster than hitherto assumed.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1704.01773
and from DOI:10.1051/0004-6361/201730385

The large-scale nebular pattern of a superwind binary in an eccentric orbit

Hyosun Kim[1,5], *Alfonso Trejo*[1], *Sheng-Yuan Liu*[1], *Raghvendra Sahai*[2], *Ronald E. Taam*[1,3], *Mark R. Morris*[4], *Naomi Hirano*[1] *and I-Ta Hsieh*[1]

[1]ASIAA, Taiwan

[2]JPL, USA

[3]Northwestern University, USA

[4]UCLA, USA

[5]EACOA

Preplanetary nebulæ and planetary nebulæ are evolved, mass-losing stellar objects that show a wide variety of morphologies. Many of these nebulæ consist of outer structures that are nearly spherical (spiral/shell/arc/halo) and inner structures that are highly asymmetric (bipolar/multipolar). The coexistence of such geometrically distinct structures is enigmatic because it hints at the simultaneous presence of both wide and close binary interactions, a phenomenon that has been attributed to stellar binary systems with eccentric orbits. Here we report new high-resolution molecular-line observations of the circumstellar spiral-shell pattern of AFGL 3068, an asymptotic giant branch star transitioning to the preplanetary nebula phase. The observations clearly reveal that the dynamics of the mass loss is influenced by the presence of an eccentric-orbit binary. This quintessential object opens a new window on the nature of deeply embedded binary stars through the circumstellar spiral-shell patterns that reside at distances of several thousand astronomical units from the stars.

Published in Nature Astronomy 1, 0060 (2017) – cover of 2017 March issue
Available from https://arxiv.org/abs/1704.00449
and from http://www.nature.com/articles/s41550-017-0060

High radiation pressure on interstellar dust computed by light-scattering simulation on fluffy agglomerates of magnesium-silicate grains with metallic-iron inclusions

Hiroshi Kimura[1]

[1]Nagoya University, Japan

Recent space missions have provided information on the physical and chemical properties of interstellar grains such as the ratio β of radiation pressure to gravity acting on the grains in addition to the composition, structure, and size distribution of the grains. Numerical simulation on the trajectories of interstellar grains captured by Stardust and returned to Earth constrained the β ratio for the Stardust samples of interstellar origin. However, recent accurate calculations of radiation pressure cross sections for model dust grains have given conflicting stories in the β ratio of interstellar grains. The β ratio for model dust grains of so-called "astronomical silicate" in the femto-kilogram range lies below unity, in conflict with $\beta \sim 1$ for the Stardust interstellar grains. Here, I tackle this conundrum by re-evaluating the β ratio of interstellar grains on the assumption that the grains are aggregated particles grown by coagulation and composed of amorphous $MgSiO_3$ with the inclusion of metallic iron. My model is entirely consistent with the depletion and the correlation of major rock-forming elements in the Local Interstellar Cloud surrounding the Sun and the mineralogical identification of interstellar grains in the Stardust and *Cassini* missions. I find that my model dust particles fulfill the constraints on the β ratio derived from not only the Stardust mission but also the *Ulysses* and *Cassini* missions. My results suggest that iron is not incorporated into silicates but exists as metal, contrary to the majority of interstellar dust models available to date.

Accepted for publication in The Astrophysical Journal Letters
Available from https://arxiv.org/abs/1704.02066

Identification of near-infrared [Se III] and [Kr VI] emission lines in planetary nebulæ

N.C. Sterling[1], *S. Madonna*[2], *K. Butler*[3], *J. García-Rojas*[2], *A.L. Mashburn*[1], *C. Morisset*[4], *V. Luridiana*[1] *and I.U. Roederer*[5,6]

[1]University of West Georgia, USA
[2]Instituto de Astrofísica de Canarias, Spain
[3]Institut für Astronomie und Astrophysik, Munich, Germany
[4]Instituto de Astronomía, UNAM, México
[5]University of Michigan, USA
[6]JINA/CEE

We identify [Se III] 1.0994 μm in the planetary nebula (PN) NGC 5315 and [Kr VI] 1.2330 μm in three PNe, from spectra obtained with the FIRE spectrometer on the 6.5-m *Baade* Telescope. Se and Kr are the two most widely-detected neutron-capture elements in astrophysical nebulæ, and can be enriched by *s*-process nucleosynthesis in PN progenitor stars. The detection of [Se III] 1.0994 μm is particularly valuable when paired with observations of [Se IV] 2.2858 μm, as it can be used to improve the accuracy of nebular Se abundance determinations, and allows Se ionization correction factor (ICF) schemes to be empirically tested for the first time. We present new effective collision strength calculations for Se^{2+} and Kr^{5+}, which we use to compute ionic abundances. In NGC 5315, we find that the Se abundance computed from Se^{3+}/H^+ is lower than that determined with ICFs that incorporate Se^{2+}/H^+. We compute new Kr ICFs that take Kr^{5+}/H^+ into account, by fitting correlations found in grids of CLOUDY models between Kr ionic fractions and those of more abundant elements, and use these to derive Kr abundances in four PNe. Observations of [Se III] and [Kr VI] in a larger sample of PNe, with a range of excitation levels, are needed to rigorously test the ICF prescriptions for Se and our new Kr ICFs.

Accepted for publication in Astrophysical Journal
Available from https://arxiv.org/abs/1704.00741

NGC 6067: a young and massive open cluster with high metallicity

J. Alonso-Santiago[1], *I. Negueruela*[1], *A. Marco*[1,2], *H.M. Tabernero*[1,3], *C. González-Fernández*[4] *and N. Castro*[5]

[1]Dpto. de Física, Ingeniería de Sistemas y Teoría de la Señal, Escuela Politécnica Superior, Universidad de Alicante, Apdo. 99 E-03080, Spain

[2]Department of Astronomy, University of Florida, 211 Bryant Space Science Center, Gainesville, FL 32611, USA

[3]Dpto de Astrofísica, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, E-28040, Madrid, Spain

[4]Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 OHA, UK

[5]Department of Astronomy, University of Michigan, 1085 S. University Avenue, Ann Arbor, MI 48109-1107, USA

NGC 6067 is a young open cluster hosting the largest population of evolved stars among known Milky Way clusters in the 50–150 Ma age range. It thus represents the best laboratory in our Galaxy to constrain the evolutionary tracks of 5–7 $M_\odot$ stars.
We have used high-resolution spectra of a large sample of bright cluster members (45), combined with archival photometry, to obtain accurate parameters for the cluster as well as stellar atmospheric parameters. We derive a distance of 1.78 ± 0.12 kpc, an age of 90 ± 20 Ma and a tidal radius of $14.8^{+6.8}_{-3.2}$ arcmin. We estimate an initial mass above 5 700 $M_\odot$, for a present-day evolved population of two Cepheids, two A supergiants and 12 red giants with masses ≈ 6 $M_\odot$. We also determine chemical abundances of Li, O, Na, Mg, Si, Ca, Ti, Ni, Rb, Y, and Ba for the red clump stars. We find a supersolar metallicity, $[\mathrm{Fe/H}] = +0.19 \pm 0.05$, and a homogeneous chemical composition, consistent with the Galactic metallicity gradient. The presence of a Li-rich red giant, star 276 with $A(\mathrm{Li}) = 2.41$, is also detected. An over-abundance of Ba is found, supporting the enhanced *s*-process.
The ratio of yellow to red giants is much smaller than one, in agreement with models with moderate overshooting, but the properties of the cluster Cepheids do not seem consistent with current Padova models for supersolar metallicity.

Accepted for publication in MNRAS
Available from https://arxiv.org/abs/1704.01548

The kinematics of the white dwarf population from the SDSS DR12

Borja Anguiano[1], *Alberto Rebassa-Mansergas*[2], *Enrique García-Berro*[2], *Santiago Torres*[2], *Ken Freeman*[3] *and Tomaz Zwitter*[4]

[1]University of Virginia, USA

[2]UPC, Spain

[3]RSAA, Australia

[4]UL, Slovenia

We use the Sloan Digital Sky Survey Data Release 12, which is the largest available white dwarf catalog to date, to study the evolution of the kinematical properties of the population of white dwarfs in the Galactic disc. We derive masses, ages, photometric distances and radial velocities for all white dwarfs with hydrogen-rich atmospheres. For those stars for which proper motions from the USNO-B1 catalog are available the true three-dimensional components of the stellar space velocity are obtained. This subset of the original sample comprises 20,247 objects, making it the largest sample of white dwarfs with measured three-dimensional velocities. Furthermore, the volume probed by our sample is large, allowing us to obtain relevant kinematical information. In particular, our sample extends from a Galactocentric radial distance $R_\mathrm{G} = 7.8$ kpc to 9.3 kpc, and vertical distances from the Galactic plane ranging from $Z = -0.5$ kpc to 0.5 kpc. We examine the mean components of the stellar three-dimensional velocities, as well as their dispersions with respect to the Galactocentric and vertical distances. We confirm the existence of a mean Galactocentric radial velocity gradient, $\partial\langle V_\mathrm{R}\rangle/\partial R_\mathrm{G} = -3 \pm 5$ km s^{-1} kpc^{-1}. We also confirm North–South differences in $\langle V_\mathrm{z}\rangle$. Specifically, we find that white dwarfs with $Z > 0$ (in the North Galactic hemisphere) have $\langle V_\mathrm{z}\rangle < 0$, while the reverse is true for white dwarfs with $Z < 0$. The age–velocity dispersion relation derived from the present sample indicates that the Galactic population of white dwarfs may have experienced an additional source of heating, which adds to the secular evolution of the Galactic disc.

Accepted for publication in MNRAS
Available from https://arxiv.org/abs/1703.09152

Recombination coefficients for O II lines in nebular conditions

P.J. Storey[1], *Taha Sochi*[1] *and Robert Bastin*[2]

[1]University College London, UK
[2]Surbiton High School, UK

We present the results of a calculation of recombination coefficients for O^{2+} + e^- using an intermediate coupling treatment that fully accounts for the dependence of the distribution of population among the ground levels of O^{2+} on electron density and temperature. The calculation is extended down to low electron temperatures where dielectronic recombination arising from Rydberg states converging on the O^{2+} ground levels is an important process. The data, which consist of emission coefficients for 8889 recombination lines and recombination coefficients for the ground and metastable states of O^+ are in Cases A, B and C, and are organised as a function of the electron temperature and number density, as well as wavelength. An interactive FORTRAN 77 data server is also provided as an accessory for mining the line emission coefficients and obtaining Lagrange interpolated values for any choice of the two variables between the explicitly provided values for any set of wavelengths. Some illustrations of the application of the new data to nebular observations are also provided.

Submitted to MNRAS
Available from https://arxiv.org/abs/1703.09982

Post main sequence evolution of icy minor planets II: water retention and white dwarf pollution around massive progenitor stars

Uri Malamud[1] *and Hagai B. Perets*[1]

[1]Technion Israel Institute of Technology, Israel

Studies suggest the pollution of white dwarf atmospheres arises from accretion of minor planets, but the exact properties of polluting material, and in particular the evidence for water in some cases are not yet understood. Here we study the water retention of small icy bodies in exo-solar planetary systems, as their respective host stars evolve through and off the main sequence and eventually becomes WDs. We explore for the first time a wide range of star masses and metallicities. We find that the mass of the WD progenitor star is of crucial importance for the retention of water, while its metallicity is relatively unimportant. We predict that minor planets around lower-mass WD progenitors would retain more water in general, and would do so at closer distances from the WD, compared with high-mass progenitors. The dependence of water retention on progenitor mass and other parameters has direct implications for the origin of observed WD pollution, and we discuss how our results and predictions might be tested in the future as more observations of WDs with long cooling-ages become available.

Submitted to ApJ
Available from https://arxiv.org/abs/1704.01165

The correlation between mixing length and metallicity on the giant branch: implications for ages in the Gaia era

Jamie Tayar[1], *Garrett Somers*[2,1], *Marc H. Pinsonneault*[1], *Dennis Stello*[3,4,5], *Alexey Mints*[6,4], *Jennifer A. Johnson*[1], *O. Zamora*[7,8], *D.A. García-Hernández*[7,8], *Claudia Maraston*[9], *Aldo Serenelli*[10], *Carlos Allende Prieto*[11], *Fabienne A. Bastien*[12,13], *Sarbani Basu*[14], *J.C. Bird*[2], *R.E. Cohen*[15], *Katia Cunha*[16], *Yvonne Elsworth*[17], *Rafael A. García*[18], *Léo Girardi*[19], *Saskia Hekker*[6,4], *Jon Holtzman*[20], *Daniel Huber*[3,21,4], *Savita Mathur*[22], *Szabolcs Mészáros*[23,24], *B. Mosser*[25], *Matthew Shetrone*[26], *Victor Silva Aguirre*[4], *Keivan Stassun*[2], *Guy S. Stringfellow*[27], *Gail Zasowski*[28] and *A. Roman-Lopes*[29]

[1]Department of Astronomy, Ohio State University, 140 W 18[th] Ave, OH 43210, USA

[2]Department of Physics and Astronomy, Vanderbilt University, 6301 Stevenson Circle, Nashville, TN, 37235, USA

[3]Sydney Institute for Astronomy (SIfA), School of Physics, University of Sydney, NSW 2006, Australia

[4]Stellar Astrophysics Centre, Department of Physics and Astronomy, Århus University, Ny Munkegade 120, DK-8000 Århus C, Denmark

[5]School of Physics, University of New South Wales, NSW 2052, Australia

[6]Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany

[7]Instituto de Astrofísica de Canarias (IAC), Vía Lactea s/n, E-38205 La Laguna, Tenerife, Spain

[8]Departamento de Astrofísica, Universidad de La Laguna (ULL), E-38206 La Laguna, Tenerife, Spain

[9]ICG – University of Portsmouth, Burnaby Road, PO1 3FX, Portsmouth, UK

[10]Institute of Space Sciences (CSIC–IEEC), Carrer de Can Magrans, Barcelona, 08193, Spain

[11]Instituto de Astrofísica de Canarias, 38205 La Laguna, Tenerife, Spain

[12]Department of Astronomy and Astrophysics, 525 Davey Lab, The Pennsylvania State University, University Park, PA 16803, USA

[13]Hubble Fellow

[14]Department of Astronomy, Yale University, New Haven, CT 06511, USA

[15]Departamento de Astronomía, Universidad de Concepción, Casilla 160-C, Concepción, Chile

[16]Observatório Nacional – MCTI, Brazil

[17]School of Physics and Astronomy, University of Birmingham, Birmingham B15 2TT, UK

[18]Laboratoire AIM, CEA/DRF–CNRS, Université Paris 7 Diderot, IRFU/SAp, Centre de Saclay, 91191, Gif-sur-Yvette, France

[19]Osservatorio Astronomico di Padova–INAF, Vicolo dell'Osservatorio 5, I-35122 Padova, Italy

[20]New Mexico State University, Las Cruces, NM 88003, USA

[21]SETI Institute, 189 Bernardo Avenue, Mountain View, CA 94043, USA

[22]Space Science Institute, 4750 Walnut Street Suite 205, Boulder, CO 80301, USA

[23]ELTE Gothard Astrophysical Observatory, H-9704 Szombathely, Szent Imre herceg st. 112, Hungary

[24]Premium Postdoctoral Fellow of the Hungarian Academy of Sciences

[25]LESIA, Observatoire de Paris, PSL Research University, CNRS, Université Pierre et Marie Curie, Université Paris Diderot, 92195 Meudon, France

[26]University of Texas at Austin, McDonald Observatory, 32 Fowlkes Rd, McDonald Observatory, TX 79734-3005, USA

[27]Center for Astrophysics and Space Astronomy, University of Colorado, 389 UCB, Boulder, Colorado, 80309-0389, USA

[28]Department of Physics and Astronomy, JHU, 3400 N. Charles St. Baltimore, MD 21218, USA

[29]Departamento de Física, Facultad de Ciencias, Universidad de La Serena, Cisternas 1200, La Serena, Chile

In the updated APOGEE–*Kepler* catalog, we have asteroseismic and spectroscopic data for over 3000 first ascent red giants. Given the size and accuracy of this sample, these data offer an unprecedented test of the accuracy of stellar models on the post-main-sequence. When we compare these data to theoretical predictions, we find a metallicity dependent temperature offset with a slope of around 100 K per dex in metallicity. We find that this effect is present in all model grids tested and that theoretical uncertainties in the models, correlated spectroscopic errors, and shifts in the asteroseismic mass scale are insufficient to explain this effect. Stellar models can be brought into agreement with the data if a metallicity dependent convective mixing length is used, with $\Delta\alpha_{\mathrm{ML,YREC}} \sim 0.2$ per dex in metallicity, a trend inconsistent with the predictions of three dimensional stellar convection simulations. If this effect is not taken into account, isochrone ages for red giants from the Gaia data will be off by as much as a factor of 2 even at modest deviations from solar metallicity ([Fe/H] $= -0.5$).

Accepted for publication in ApJ
Available from https://arxiv.org/abs/1704.01164
and from http://www.astronomy.ohio-state.edu/∼tayar/MixingLength.htm

Three-dimensional hydrodynamical models of wind and outburst-related accretion in symbiotic systems

M. de Val-Borro[1], M. Karovska[2], D.D. Sasselov[2] and J.M. Stone[3]

[1]NASA GSFC, USA

[2]Harvard–Smithsonian Center for Astrophysics, USA

[3]Princeton University, USA

Gravitationally focused wind accretion in binary systems consisting of an evolved star with a gaseous envelope and a compact accreting companion is a possible mechanism to explain mass transfer in symbiotic binaries. We study the mass accretion around the secondary caused by the strong wind from the primary late-type component using global three-dimensional hydrodynamic numerical simulations during quiescence and outburst stages. In particular, the dependence of the mass accretion rate on the mass-loss rate, wind parameters and phases of wind outburst development is considered. For a typical wind from an asymptotic giant branch star with a mass-loss rate of 10^{-6} $M_{\odot}$ yr^{-1} and wind speeds of 20–50 km s^{-1}, the mass transfer through a focused wind results in efficient infall on to the secondary. Accretion rates onto the secondary of 5–20 per cent of the mass-loss from the primary are obtained during quiescence and outburst periods where the wind velocity and mass-loss rates are varied, about 20–50 per cent larger than in the standard Bondi–Hoyle–Lyttleton approximation. This mechanism could be an important method for explaining observed accretion luminosities and periodic modulations in the accretion rates for a broad range of interacting binary systems.

Published in MNRAS, 468, 3408 (2017)
Available from https://arxiv.org/abs/1704.03460
and from https://doi.org/10.1093/mnras/stx684

Testing a one-dimensional prescription of dynamical shear mixing with a two-dimensional hydrodynamic simulation

Philipp V.F. Edelmann[1], Friedrich K. Röpke[1,2], Raphæl Hirschi[3,4,5], Cyril Georgy[6,3] and Samuel Jones[1]

[1]Heidelberger Institut für Theoretische Studien, Schloß-Wolfsbrunnenweg 35, D-69118 Heidelberg, Germany

[2]Zentrum für Astronomie der Universität Heidelberg, Institut für Theoretische Astrophysik, Philosophenweg 12, D-69120 Heidelberg, Germany

[3]Astrophysics group, Keele University, Lennard-Jones Laboratories, Keele ST5 5BG, UK

[4]Kavli Institute for the Physics and Mathematics of the Universe (WPI), University of Tokyo, 5-1-5 Kashiwanoha, 277-8583 Kashiwa, Japan

[5]Kashiwa, Japan UK Network for Bridging Disciplines of Galactic Chemical Evolution (BRIDGCE), http://www.bridgce.ac.uk/, UK

[6]Geneva Observatory, University of Geneva, Maillettes 51, CH-1290 Sauverny, Switzerland

The treatment of mixing processes is still one of the major uncertainties in 1D stellar evolution models. This is mostly due to the need to parametrize and approximate aspects of hydrodynamics in hydrostatic codes. In particular, the effect of hydrodynamic instabilities in rotating stars, for example, dynamical shear instability, evades consistent description. We intend to study the accuracy of the diffusion approximation to dynamical shear in hydrostatic stellar evolution models by comparing 1D models to a first-principle hydrodynamics simulation starting from the same initial conditions. We chose an initial model calculated with the stellar evolution code GENEC that is just at the onset of a dynamical shear instability but does not show any other instabilities (e.g., convection). This was mapped to the hydrodynamics code SLH to perform a 2D simulation in the equatorial plane. We compare the resulting profiles in the two codes and compute an effective diffusion coefficient for the hydro simulation. Shear instabilities develop in the 2D simulation in the regions predicted by linear theory to become unstable in the 1D model. Angular velocity and chemical composition is redistributed in the unstable region, thereby creating new unstable regions. Eventually the 2D simulation settles in a symmetric, steady state, which is Richardson stable everywhere, whereas the instability remains for longer in the 1D model due to current limitations in the 1D code. A spatially resolved diffusion coefficient is extracted by comparing the initial and final profiles of mean atomic mass. The presented simulation gives a first

insight on hydrodynamics of shear instabilities in a real stellar environment and even allows us to directly extract an effective diffusion coefficient. We see evidence for a critical Richardson number of 0.25 as regions above this value remain stable for the course of the simulation.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1704.06261
and from https://slh-code.org/papers/dynshear

Evidence for binarity and possible disk obscuration in *Kepler* observations of the pulsating RV Tau variable DF Cygni

Laura D. Vega[1,2], *Keivan G. Stassun*[1,2], *Rodolfo Montez Jr.*[3], *Patricia T. Boyd*[4] *and Garrett Somers*[1,5]

[1]Vanderbilt University, USA
[2]Fisk University, USA
[3]Smithsonian Astrophysical Observatory, USA
[4]NASA Goddard Space Flight Center, USA
[5]VIDA Postdoctoral Fellow

The *Kepler* light curve of DF Cyg is unparalleled in precision and cadence for any RV Tau star to date spanning a baseline of ~ 4 years and clearly displaying the signature pulsating behavior of alternating deep and shallow minima as well as the long-term trend indicative of an RVb-type variable. We measure DF Cyg's formal period (the time interval between two successive deep minima) to be 49.84 ± 0.02 days. The trend in the arrival times emulates that of the long-term period. There appear to be precisely 16 deep+shallow minima cycles in one long-term cycle, suggesting a long-term cycle period of $\approx 795 \pm 5$ days. We argue that binarity may naturally explain the long-term periodicity in DF Cyg. The spectral energy distribution of DF Cyg features an infrared excess indicative of a disk possibly linked to a binary companion. From a recent Gaia parallax measurement for DF Cyg, we calculated that it has a distance of 990 ± 372 pc and a physical radius of $R_\star = 10.3 \pm 3.8$ R$_\odot$. From kinematics and geometric arguments, we argue that the most likely interpretation for the decrease in flux from the long-period maximum to the long-period minimum, as well as the reduction of the short-term pulsation amplitude, is caused by an occulting body such as a disk surrounding DF Cyg and its binary companion.

Published in The Astrophysical Journal, 839, 48 (2017)
Available from https://arxiv.org/abs/1703.08566
and from http://iopscience.iop.org/article/10.3847/1538-4357/aa67dd

High-resolution optical spectroscopic observations of four symbiotic stars : AS 255, MWC 960, RW Hya and StHα 32

C.B. Pereira[1], *N.O. Baella*[2,3,], *N.A. Drake*[1,4], *L.F. Miranda*[5] *and F. Roig*[1]

[1]Observatório Nacional, Rio de Janeiro, Brazil
[2]Unidad de Astronomía, Instituto Geofísico del Perú, Lima, Perú
[3]Departamento de Ciencias, Sección Física, Pontificia Universidad Católica del Perú, Apartado 1761, Lima, Perú
[4]Saint Petersburg State University, Universitetski pr., 28, 198504, Saint Petersburg, Russia
[5]Instituto de Astrofísica de Andalucía–CSIC, C/ Glorieta de la Astronomía s/n, E-18008 Granada, Spain

We report on the analysis of high resolution optical spectra of four symbiotic stars AS 255, MWC 960, RW Hya, and StHα 32. We employ the local-thermodynamic-equilibrium model atmospheres of Kurucz and the spectral analysis code MOOG to analyze the spectra. The abundance of barium and carbon was derived using spectral synthesis technique. The chemical composition of the atmospheres of AS 255 and MWC 960 show that they are metal-poor K giants with metallicities −1.7 and −1.2, respectively. StHα 32 is a CH star and also a low metallicity object (−1.4). AS 255 and MWC 960 are yellow symbiotic stars and, like other previously studied yellow symbiotics, are s-process enriched. StHα 32 alike other CH stars, is also an s-process and carbon enriched object. RW Hya has a metallicity of −0.64, a value in accordance with previous determinations, and is not s-process enriched. Based on its position in the 2MASS diagram, we suggest that RW Hya is at an intermediate position between yellow symbiotics and classical S-type symbiotics. We also discuss whether dilution effect was the mechanism responsible for the absence of the s-process elements overabundance in RW Hya. The luminosity obtained for StHα 32 is below the luminosity of the asymptotic giant branch (AGB) stars that started helium burning (via thermal pulses) and became self-enriched in neutron-capture elements. Therefore, its abundance peculiarities are due to mass transfer from the previous thermally pulsing AGB star (now the white dwarf) that was overabundant in s-process elements. For the stars AS 255 and MWC 960 determination of their luminosities was not possible due to uncertainties in their distance and interstellar absorption. AS 255 and MWC 960 have a low Galactic latitude and could be bulge stars or members of the inner halo population. The heavy-element abundance distribution of AS 255 and MWC 960 is similar to that of other yellow symbiotics previously analyzed. Their abundance pattern follow that of the thick disk population for RW Hya and of the halo population for AS 255, MWC 960 and StHα 32. We also determined the rotational velocities of these four symbiotic stars and compare our results with those of single field stars.

Accepted for publication in The Astrophysical Journal

Nucleation of small silicon carbide dust clusters in AGB stars

D. Gobrecht[1], S. Cristallo[1], L. Piersanti[1] and S.T. Bromley[2,3]

[1]Osservatorio Astronomico di Teramo, INAF, 64100 Teramo, Italy

[2]Departament de Ciencia de Materials i Quimica Fisica and Institut de Quimica Teorica i Computacional (IQTCUB), Universitat de Barcelona, E-08028 Barcelona, Spain

[3]Institucio Catalana de Recerca i Estudis Avancats (ICREA), 08010 Barcelona, Spain

Silicon carbide (SiC) grains are a major dust component in carbon-rich AGB stars. The formation pathways of these grains are, however, not fully understood. We calculate ground states and energetically low-lying structures of $(SiC)_n$, $n = 1, 16$ clusters by means of simulated annealing (SA) and Monte Carlo simulations of seed structures and subsequent quantum-mechanical calculations on the density functional level of theory. We derive the infrared (IR) spectra of these clusters and compare the IR signatures to observational and laboratory data. According to energetic considerations, we evaluate the viability of SiC cluster growth at several densities and temperatures, characterising various locations and evolutionary states in circumstellar envelopes. We discover new, energetically low-lying structures for Si_4C_4, Si_5C_5, $Si_{15}C_{15}$ and $Si_{16}C_{16}$, and new ground states for $Si_{10}C_{10}$ and $Si_{15}C_{15}$. The clusters with carbon-segregated substructures tend to be more stable by 4–9 eV than their bulk-like isomers with alternating Si–C bonds. However, we find ground states with cage ("bucky"-like) geometries for $Si_{12}C_{12}$ and $Si_{16}C_{16}$ and low-lying, stable cage structures for $n \geq 12$. The latter findings indicate thus a regime of clusters sizes that differs from small clusters as well as from large-scale crystals. Thus, and owing to their stability and geometry, the latter clusters may mark a transition from a quantum-confined cluster regime to crystalline, solid bulk-material.
The calculated vibrational IR spectra of the ground-state SiC clusters shows significant emission. They include the 10–13 μm wavelength range and the 11.3-μm feature inferred from laboratory measurements and observations, respectively, though the overall intensities are rather low.

Accepted for publication in ApJ

ALMA observations of the nearby AGB star L_2 Puppis. II. Gas disk properties derived from ^{12}CO and ^{13}CO $J = 3$–2 emission

Ward Homan[1], Anita M.S. Richards[2], Leen Decin[1], Pierre Kervella[3,4], Alex de Koter[1,5], Iain McDonald[2] and Keiichi Onaka[6]

[1]Institute of Astronomy, K.U. Leuven, Celestijnenlaan 200D B2401, 3001 Leuven, Belgium

[2]JBCA, Department Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK

[3]Unidad Mixta Internacional Franco–Chilena de Astronomía (CNRS UMI 3386), Departamento de Astronomía, Universidad de Chile, Camino El Observatorio 1515, Las Condes, Santiago, Chile

[4]LESIA (UMR 8109), Observatoire de Paris, PSL Research University, CNRS, UPMC, Univ. Paris-Diderot, 5 Place Jules Janssen, 92195 Meudon, France

[5]Sterrenkundig Instituut "Anton Pannekoek", Science Park 904, 1098 XH Amsterdam, The Netherlands

[6]Universidad Catolica del Norte, Instituto de Astronomía, Avenida Angamos 0610, Antofagasta, Chile

The circumstellar environment of the AGB star L_2 Puppis was observed with ALMA in cycle 3, with a resolution of 15–18 mas. The molecular emission shows a differentially rotating disk, inclined to a nearly edge-on position. In the first paper in this series (paper I) the molecular emission was analysed to accurately deduce the motion of the gas in the equatorial regions of the disk. In this work we model the optically thick ^{12}CO $J = 3$–2 and the optically thin ^{13}CO $J = 3$–2 rotational transition to constrain the physical conditions in the disk. To realise this effort we make use of the 3D NLTE radiative transfer code LIME. The temperature structure and velocity structure show a high degree of complexity, both radially and vertically. The radial H_2 density profile in the disk plane is characterised by a power law with a slope of -3.1. We find a ^{12}CO over ^{13}CO abundance ratio of 10 inside the disk. Finally, estimations of the angular momentum in the disk surpass the expected available angular momentum of the star, strongly supporting the indirect detection of a compact binary companion reported in paper I. We estimate the mass of the companion to be around 1 Jupiter mass.

Published in A&A, 601, A5 (2017)

Measuring surface magnetic fields of red supergiant stars

Benjamin Tessore[1], Agnes Lèbre[1], Julien Morin[1], Philippe Mathias[2,3], Eric Josselin[1,2,3] and Michel Aurière[2,3]

[1]LUPM, Université de Montpellier, CNRS, Place Eugène Bataillon, 34095, France

[2]Université de Toulouse, UPS–OMP, Institut de recherche en Astrophysique et Planétologie, Toulouse, France

[3]CNRS, UMR5277, Institut de recherche en Astrophysique et Planétologie, 14 Avenue Edouard Belin, 31400 Toulouse, France

Red Supergiant (RSG) stars are very massive cool evolved stars. Recently, a weak magnetic field has been measured at the surface of α Ori and this is so far the only M-type supergiant for which a direct detection of a surface magnetic field has been reported. By extending the search for surface magnetic field in a sample of late-type supergiants, we want to determine whether the surface magnetic field detected on α Ori is a common feature among the M-type supergiants. With the spectropolarimeter Narval at Télescope *Bernard-Lyot* we have undertaken the search for surface magnetic field in a sample of cool supergiant stars, and we have analysed circular polarisation spectra using the Least Squares Deconvolution technique. We have detected weak Zeeman signatures of stellar origin in the targets CE Tau, α^1 Her and μ Cep. For the latter star, we also show that cross-talk from the strong linear polarisation signals detected on this star must be taken into account. For CE Tau and μ Cep, the longitudinal component of the detected surface fields is at the Gauss level, just like in α Ori. We have measured a longitudinal field almost an order of magnitude stronger for α^1 Her. We also report variability of the longitudinal magnetic field of CE Tau and α^1 Her, with changes in good agreement with the typical atmospheric dynamics time-scales. We also report a non-detection of magnetic field at the surface of the yellow supergiant star ρ Cas. The two RSG stars of our sample – CE Tau and μ Cep – display magnetic fields very similar to that of α Ori. The non-detection of a magnetic field on the post-RSG star ρ Cas suggests that the magnetic field disappears, or at least becomes undetectable with present methods, at later evolutionary stages. Our analysis of α^1 Her supports the proposed reclassification of the star as an M-type AGB star.

Accepted for publication in Astronomy and Astrophysics

Chempy: A flexible chemical evolution model for abundance fitting – Do the Sun's abundances alone constrain chemical evolution models?

Jan Rybizki[1,2], *Andreas Just*[2] *and Hans-Walter Rix*[1]

[1]Max Planck Institute for Astronomy, Germany

[2]Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Germany

Elemental abundances of stars are the result of the complex enrichment history of their galaxy. Interpretation of observed abundances requires flexible modeling tools to explore and quantify the information about Galactic chemical evolution (GCE) stored in such data. Here we present Chempy, a newly developed code for GCE modeling, representing a parametrized open one-zone model within a Bayesian framework. A Chempy model is specified by a set of 5–10 parameters that describe the effective galaxy evolution along with the stellar and star-formation physics: e.g., the star-formation history (SFH), the feedback efficiency, the stellar initial mass function (IMF) and the incidence of supernova of type Ia (SN Ia). Unlike established approaches, Chempy can sample the posterior probability distribution in the full model parameter space and test data-model matches for different nucleosynthetic yield sets. It is essentially a chemical evolution fitting tool. We straightforwardly extend Chempy to a multi-zone scheme. As an illustrative application, we show that interesting parameter constraints result from only the ages and elemental abundances of Sun, Arcturus and the present-day interstellar medium (ISM). For the first time, we use such information to infer IMF parameter via GCE modeling, where we properly marginalize over nuisance parameters and account for different yield sets. We find that $11.6^{+2.1}_{-1.6}\%$ of the IMF explodes as core-collapse SN (CC-SN), compatible with Salpeter (1955). We also constrain the incidence of SN Ia per 10^3 $M_\odot$ to 0.5–1.4. At the same time, this Chempy application shows persistent discrepancies between predicted and observed abundances for some elements, irrespective of the chosen yield set. These cannot be remedied by any variations of Chempy's parameters and could be an indication for missing nucleosynthetic channels. Chempy should be a powerful tool to confront predictions from stellar nucleosynthesis with far more complex abundance data sets and to refine the physical processes governing the chemical evolution of stellar systems.

Accepted for publication in A&A
Available from https://arxiv.org/abs/1702.08729
and from https://github.com/jan-rybizki/Chempy

The impact of atomic data selection on nebular abundance determinations

Leticia Juan de Dios[1] *and Mónica Rodríguez*[1]

[1]Instituto Nacional de Astrofísica Óptica y Electrónica, Luis Enrique Erro 1, Tonantzintla 72840, Puebla, México

Atomic data are an important source of systematic uncertainty in our determinations of nebular chemical abundances. However, we do not have good estimates of these uncertainties since it is very difficult to assess the accuracy of the atomic data involved in the calculations. We explore here the size of these uncertainties by using 52 different sets of transition probabilities and collision strengths, and all their possible combinations, to calculate the physical conditions and the total abundances of O, N, S, Ne, Cl, and Ar for a sample of planetary nebulæ and H II regions. We find that atomic data variations introduce differences in the derived abundance ratios as low as 0.1–0.2 dex at low density, but that reach or surpass 0.6–0.8 dex at densities above 10^4 cm^{-3} in several abundance ratios, like O/H and N/O. Removing from the 52 datasets the four datasets that introduce the largest differences, the total uncertainties are reduced, but high density objects still reach uncertainty factors of four for their values of O/H and N/O. We identify the atomic data that introduce most of the uncertainty, which involves the ions used to determine density, namely, the transition probabilities of the S^+, O^+, Cl^{++}, and Ar^{3+} density diagnostic lines, and the collision strengths of Ar^{3+}. Improved calculations of these data will be needed in order to derive more reliable values of chemical abundances in high density nebulæ. In the meantime, our results can be used to estimate the uncertainties introduced by atomic data in nebular abundance determinations.

Accepted for publication in MNRAS
Available from https://arxiv.org/abs/1704.06009

Pulsations of intermediate-mass stars on the asymptotic giant branch

Yu.A. Fadeyev[1]

[1]Institute of Astronomy of the Russian Academy of Sciences, Russia

Evolutionary tracks from the zero age main sequence to the asymptotic giant branch were computed for stars with initial masses $2\ M_\odot \le M_{\rm ZAMS} \le 5\ \mathrm{M}_\odot$ and metallicity $Z = 0.02$. Some models of evolutionary sequences were used as initial conditions for equations of radiation hydrodynamics and turbulent convection describing radial stellar pulsations. The early asymptotic giant branch stars are shown to pulsate in the fundamental mode with periods from 30 to 400 day. The rate of period change gradually increases as the star evolves but is too small to be detected ($\dot{\Pi}/\Pi < 10^{-5}$ yr$^{-}1$). Pulsation properties of thermally pulsing AGB stars are investigated on time intervals comprising 17 thermal pulses for evolutionary sequences with intial masses $M_{\rm ZAMS} = 2\ \mathrm{M}_\odot$ and $3\ \mathrm{M}_\odot$ and 6 thermal pulses for $M_{\rm ZAMS} = 4\ \mathrm{M}_\odot$ and $5\ \mathrm{M}_\odot$. TP-AGB stars with initial masses $M_{\rm ZAMS} \le 3\ \mathrm{M}_\odot$ pulsate either in the fundamental mode or in the first overtone, whereas more massive red giants ($M_{\rm ZAMS} \ge 4\ \mathrm{M}_\odot$) pulsate in the fundamental mode with periods as long as 10^3 day. Most rapid pulsation period change with rate $-0.02 < \dot{\Pi}/\Pi < -0.01$ yr^{-1} occurs during decrease of the surface luminosity after the maximum helium luminosity. The rate of subsequent increase of the period is $\dot{\Pi}/\Pi \le 5 \times 10^{-3}$ yr^{-1}.

Accepted for publication in Astronomy Letters
Available from https://arxiv.org/abs/1704.07808

Lithium abundance and ^{6}Li/^{7}Li ratio in the active giant HD 123351. I. A comparative analysis of 3D and 1D NLTE line-profile fits

A. Mott[1]*, M. Steffen*[1]*, E. Caffau*[2]*, F. Spada*[1] *and K.G. Straßmeier*[1]

[1]Leibniz-Institut für Astrophysik Potsdam, An der Sternwarte 16, 14482 Potsdam, Germany

[2]GEPI, Observatoire de Paris, PSL Research University, CNRS, Place Jules Janssen, 92195 Meudon, France

Current three-dimensional (3D) hydrodynamical model atmospheres together with detailed spectrum synthesis, accounting for departures from Local Thermodynamic Equilibrium (LTE), permit to derive reliable atomic and isotopic chemical abundances from high-resolution stellar spectra. Not much is known about the presence of the fragile ^{6}Li isotope in evolved solar-metallicity red giant branch (RGB) stars, not to mention its production in magnetically active targets like HD 123351. A detailed spectroscopic investigation of the lithium resonance doublet in HD 123351 in terms of both abundance and isotopic ratio is presented. From fits of the observed spectrum, taken at the Canada–France–Hawai'i telescope, with synthetic line profiles based on 1D and 3D model atmospheres, we seek to estimate the abundance of the ^{6}Li isotope and to place constraints on its origin. We derive the lithium abundance A(Li) and the ^{6}Li/^{7}Li isotopic ratio by fitting different synthetic spectra to the Li-line region of a high-resolution CFHT spectrum ($R = 120\,000$, $SNR = 400$). The synthetic spectra are computed with four different line lists, using in parallel 3D hydrodynamical CO5BOLD and 1D LHD model atmospheres and treating the line formation of the lithium components in non-LTE (NLTE). The fitting procedure is repeated with different assumptions and wavelength ranges to obtain a reasonable estimate of the involved uncertainties. We find $A(\mathrm{Li}) = 1.69 \pm 0.11$ dex and $^6\mathrm{Li}/^7\mathrm{Li} = 8.0 \pm 4.4\%$ in 3D-NLTE, using the line list of Meléndez et al. (2012), updated with new atomic data for V I, which results in the best fit of the lithium line profile of HD 123351. Two other line lists lead to similar results but with inferior fit qualities. Our 2-σ detection of the ^{6}Li isotope is the result of a careful statistical analysis and the visual inspection of each achieved fit. Since the presence of a significant amount of ^{6}Li in the atmosphere of a cool evolved star is not expected in the framework of standard stellar evolution theory, non-standard, external lithium production mechanisms, possibly related to stellar activity or a recent accretion of rocky material, need to be invoked to explain the detection of ^{6}Li in HD 123351.

Accepted for publication in A&A
Available from https://arxiv.org/abs/1704.06460

Kinematic and chemical study of planetary nebulæ and H II regions in NGC 3109

S.N. Flores-Durán[1], *M. Peña*[1] *and M.T. Ruiz*[2]

[1]Instituto de Astronomía Universidad Nacional Autónoma de México, México

[2]Depto. de Astronomía, Universidad de Chile, Chile

Aims: We present high-resolution spectroscopy of a number of planetary nebulæ (PNe) and H II regions distributed along the dwarf irregular galaxy NGC 3109 and compare their kinematical behavior with that of H I data. We aim to determine if there is a kinematical connection among these objects. We also aim to determine the chemical composition of some PNe and H II regions in this galaxy and discuss it in comparison with stellar evolution models.
Methods: Data for eight PNe and one H II region were obtained with the high-resolution spectrograph *Magellan Inamori Kyocera* Échelle (MIKE) at Las Campanas Observatory, Chile. Data for three PNe, six compact H II regions, and nine knots or clumps in extended H II regions were obtained with the high-resolution spectrograph Manchester Échelle Spectrometer (MES) attached to the 2.1-m telescope at the Observatorio Astronómico Nacional, SPM, B.C., México. An additional object was obtained from The SPM Catalogue of Extragalactic Planetary Nebulæ. Thus, in total we have high-quality data for nine of the 20 PNe detected in this galaxy, and many H II regions. In the wavelength calibrated spectra, the heliocentric radial velocities were measured with a precision better than 7.8 km s^{-1}. Data for blue supergiant stars were collected from the literature to be included in the analysis. The heliocentric radial velocities of the different objects were compared to the velocities of the H I disk at the same position. Physical conditions and ionic abundances of PNe and H II regions were obtained from the emission lines, and we used recent ionization correction factors to derive the total chemical abundances.
Results: From the analysis of radial velocities we found that H II regions in NGC 3109 share the kinematics of the H I disk at the same projected position with very low dispersion in velocities. Blue supergiant stars and PNe rotate in the same direction as the H I disk but these objects have much larger dispersion; this larger dispersion is possibly because these objects belong to a different population that is located in the central stellar bar reported for this galaxy. From the chemical abundance determinations we demonstrate that PNe are enriched in O and Ne. The average O abundance in H II regions is $12 + \log \mathrm{O/H} = 7.74 \pm 0.09$ and PNe show significantly higher oxygen abundance by 0.43 dex in average. Ne abundance are about three times larger in PNe than in H II regions. This is a very important result showing that because of the low metallicity in the galaxy, O and Ne in PNe have been enriched by their progenitors in nucleosynthesis processes and brought to the surface during third dredge-up events. Our PN abundances are better reproduced by some nonstandard stellar evolution models for a metallicity of $Z = 0.001$, similar to the metallicity of H II regions. Abundances in H II regions show no metallicity gradient in this galaxy. We discuss a possible connection between the kinematics and chemistry.

Accepted for publication in Astronomy & Astrophysics
Available from DOI: 10.1051/0004- 6361/201629040

Conference Paper

Pulsating stars in the VMC survey

Maria-Rosa L. Cioni[1,2], *Vincenzo Ripepi*[3], *Gisella Clementini*[4], *Martin A.T. Groenewegen*[5], *Maria I. Moretti*[3], *Tatiana Muraveva*[4] *and Smitha Subramanian*[6]

[1]Leibniz-Institute for Astrophysics Potsdam, An der Sternwarte 16, 14482 Potsdam, Germany
[2]University of Hertfordshire, PAM, College Lane, Hatfield, AL10 9AB, United Kingdom
[3]INAF–Osservatorio Astronomico di Capodimonte, Salita Moiariello 16, 80131 Napoli, Italy
[4]INAF–Osservatorio Astronomico di Bologna, via Gobetti 93/3, 40129 Bologna, Italy
[5]Royal Observatory of Belgium, Ringlaan 3, 1180 Brussels, Belgium
[6]Kavli Intitute for Astronomy & Astrophysics, Peking University, Yi He Yuan Lu 5, Hai Dian District, Beijing 100871, China

The VISTA survey of the Magellanic Clouds system (VMC) began observations in 2009 and since then, it has collected multi-epoch data at K_{s} and in addition multi-band data in Y and J for a wide range of stellar populations across the Magellanic system. Among them are pulsating variable stars: Cepheids, RR Lyræ, and asymptotic giant branch stars that represent useful tracers of the host system geometry.

Oral contribution, published in "Wide-field variability surveys: a 21$^{\mathrm{st}}$-century perspective", San Pedro de Atacama, Chile
Available from https://arxiv.org/abs/1703.06769

Review Paper

Super-AGB stars and their role as electron capture supernova progenitors

Carolyn L. Doherty[1,2], *Pilar Gil-Pons*[3,4], *Lionel Siess*[5] *and John C. Lattanzio*[2]

[1]Konkoly Observatory, Hungarian Academy of Sciences, 1121 Budapest, Hungary
[2]Monash Centre for Astrophysics, School of Physics and Astronomy, Monash University, Australia
[3]Polytechnical University of Catalonia, Barcelona, Spain
[4]Institut d'Estudis Espacials de Catalunya, Barcelona, Spain
[5]Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, ULB, Belgium

We review the lives, deaths and nucleosynthetic signatures of intermediate mass stars in the range approximately 6.5–11 $\mathrm{M}_{\odot}$, which form super-AGB stars near the end of their lives. We examine the critical mass boundaries both between different types of massive white dwarfs (CO, CO–Ne, ONe) and between white dwarfs and supernovae and discuss the relative fraction of super-AGB stars that end life as either an ONe white dwarf or as a neutron star (or an ONeFe white dwarf), after undergoing an electron-capture supernova. We also discuss the contribution of the other potential single-star channels to electron-capture supernovæ, that of the failed massive stars. We describe the factors that influence these different final fates and mass limits, such as composition, the efficiency of convection, rotation, nuclear reaction rates, mass loss rates, and third dredge-up efficiency. We stress the importance of the binary evolution channels for producing electron-capture supernovæ. We discuss recent nucleosynthesis calculations and elemental yield results and present a new set of s-process heavy element yield predictions. We assess the contribution from super-AGB star nucleosynthesis in a Galactic perspective, and consider the (super-)AGB scenario in the context of the multiple stellar populations seen in globular clusters. A brief summary of recent works on dust production is included. Lastly we conclude with a discussion of the observational constraints and potential future advances for study into these stars on the low mass/high mass star boundary.

Published in Publications of the Astronomical Society of Australia – special issue on "Electron Capture Supernovæ"
Available from https://arxiv.org/abs/1703.06895

Job Adverts

Postdoctoral position

Our research group in the Department of Physics & Astronomy at Western University in London, Canada has a postdoctoral position available, to work on stellar populations and star formation in nearby galaxies. The successful applicant will use multiwavelength observations and innovative computational and statistical techniques to put together the big picture of galaxy formation. She or he will carry out independent as well as directed research and be eligible to apply for telescope time with CFHT, Gemini, ALMA, and JCMT.

Candidates must have a PhD in astrophysics or related fields and experience with astronomical observations. Expertise in studies of nearby galaxies and/or in data analysis using advanced statistical methods including machine learning would be advantageous.

The initial appointment is for 1 year with the expectation of one or two additional years dependent upon performance and continued funding. The start date is flexible, but preferably not later than September 2017. The position will remain open until filled; review of applications will begin on May 1, 2017.

Applicants should send a cover letter, CV, brief statement of research interests, and contact information for at least 2 references in a single PDF to Prof. Pauline Barmby, via Ms. Stephanie Attardi, sattard3@uwo.ca. Questions about the position can be addressed to Prof. Barmby, pbarmby@uwo.ca; more information about our research group can be found at Western Research on Nearby Galaxies.

The University of Western Ontario is committed to employment equity and welcomes applications from all qualified women and men, including visible minorities, Aboriginal persons and persons with disabilities.

See also http://nearby-galaxies.github.io/postdoc-wanted

PhD bursary

The department of Astronomy at the University of Cape Town (UCT), South Africa, invites applications for a PhD position in astronomy. This position is funded through a PhD scholarship of the Faculty of Science at UCT. Funding is aligned to the SKA standard for PhD scholarships in South Africa. The deadline for applications is 15 May 2017, and we envisage a starting date of 1 July 2017. We invite applications in the following areas (among others) for one PhD position:

Stellar and Galactic Astrophysics:

- Evolved stars in Local Group galaxies and the distance scale [principal supervisors: Prof. Patricia Whitelock and Prof. Michael Feast]
- 3D simulations of stellar interactions and explosions [principal supervisor: Dr. Shazrene Mohamed]

See URL for full details: http://www.ast.uct.ac.za/node/171

Postdoctoral position: The physics and chemistry of interstellar and circumstellar clouds

We seek a candidate with a PhD, preferentially in Astrophysics, for a postdoctoral research position on the study of the physics and chemistry of interstellar and/or circumstellar clouds. The goal of the project is to develop models that include basic physical and chemical processes to confront with astronomical observations obtained with millimeter-to-optical observatories (ALMA, IRAM, SOFIA, JWST, GTC). The ideal candidate should have experience in the development of numerical models studying aspects such as the energy balance, hydrodynamics, shocks, chemical processes on the gas phase and on grain surfaces, radiative transfer, etc. We will also consider candidates with a background in the analysis of data gathered with (sub-)millimeter, infrared, and optical telescopes.

The postdoc will take part of the Molecular Astrophysics group of CSIC, based in Madrid (Spain). The selected candidate will be employed for a period of 2 to 3 years (depending of funding and status of the project) with a salary that will depend on research experience. The preferred starting date is September 2017, although it may be adapted to the selected candidate.

Application:
If you are interested, please send a Curriculum Vitæ and a short letter of motivation to the following e-mail address: marcelino.agundez@icmm.csic.es.
Applications received before June 2017 will receive full consideration.

For further details you can contact:
Dr. Marcelino Agúndez Chico
marcelino.agundez@icmm.csic.es

Announcements

Cloudy workshop
2017 July 21 to August 4
Queen's University, Belfast, Northern Ireland

Cloudy is a large-scale code that simulates the microphysics of matter exposed to ionizing radiation. It calculates the atomic physics, chemistry, radiation transport, and dynamics problems simultaneously and self-consistently, building from a foundation of individual atomic and molecular processes. The result is a prediction of the conditions in the material and its observed spectrum.

The workshop will cover observation, theory, and application of Cloudy to a wide variety of astronomical environments. This includes the theory of diffuse matter and quantitative spectroscopy, the science of using spectra to make physical measurements. We will use Cloudy to simulate such objects as AGB stars, Active Galactic Nuclei, Starburst galaxies, and the intergalactic medium.

The sessions will consist of a mix of textbook study, using Osterbrock & Ferland, "Astrophysics of Gaseous Nebulæ and Active Galactic Nuclei", application of Cloudy to a variety of astrophysical problems, and projects organized by the participants. No prior experience with Cloudy is assumed although some knowledge of spectroscopy and the physics of the interstellar medium is useful.

See also https://star.pst.qub.ac.uk/wiki/doku.php/public/cloudy2017

Asymmetric Planetary Nebulæ VII: 4–8 December 2017

Registrations are now open.

The 7th international conference in the highly regarded series on "Asymmetric Planetary Nebulæ" will take place in Hong Kong SAR, China from Monday December 4th to Friday December 8th, 2017. The venue is the wonderful "Auberge Hotel" in Discovery Bay, Hong Kong which is also where we hope most delegates will be based. There will be a welcome reception on the Sunday evening.

For details please visit the conference website: http://www.apn7.com The major themes of this meeting are:

- Shaping Mechanisms – rôle of binarity, magnetic fields & other factors
- What can we learn from the major increase in known PNe?
- How are post-AGB, pre-PNe and PNe phase shapes related?
- What rôle do the properties of the central stars play?
- What can we learn from jets and accretion disks in related/unrelated objects?
- What do advances in evolutionary models and timescales tell us?
- How do we maximally extract science from the available/planned facilities?
- What are the most important current issues to resolve?

Confirmed Invited speakers: Bruce Balick (USA); Adam Frank (USA); David Frew (Hong Kong); Martin Guerrero (Spain); Robert Izzard (UK); Amit Kashi (Israel); Eric Lagadec (France); Max Moe (USA); Sofia Ramstedt (Sweden); Valerio Ribeiro (Botswana); Carmen Sánchez Contreras (Spain); Wolfgang Steffen (México); Hans Van Winkel (Belgium); Eva Villaver (Spain); Wouter Vlemmings (Sweden); Roger Wesson (UK).

Plenty of time for discussions throughout the scientific program will be made available. There will also be a Conference Proceedings (see web site) so all our great talks and reviews can be assembled in a special issue for handy reference.

We look forward to welcoming you to Hong Kong and to an exciting and vibrant meeting.

For details of the Conference venue see http://www.aubergediscoverybay.com.

Contact: apn7conf@gmail.com

See also http://www.apn7.com